PRESIDENTIAL ADDRESS.

By HENRY G. SMITH, F.C.S.

[*Delivered to the Royal Society of N.S. Wales, May 6th, 1914.*]

IT is now my privilege, on this, the ninety-third anniversary of the foundation of this Society, to address you as your President. It gives me great pleasure to be able to congratulate you on the present satisfactory position of the Society; the membership has increased, and no less than eleven new members were admitted on one evening. The financial statement, together with other items of interest concerning the progress of the Society, will be found recorded in the report from the Council, published in another portion of the Journal.

Considerable interest was taken by the members in the proceedings at the monthly meetings, and the four popular Science Lectures were well attended, not only by the members, but also by the general public. In some instances the available room was not sufficient to accommodate all who wished to be present. This attempt by the Society to popularise science in Sydney is to be commended, and should be continued. It speaks well for the active interest in science, that members are willing to undertake the great trouble of preparing lectures of the nature of those so far given, and such effort must tend eventually to awaken more general interest in scientific subjects.

The Society is, therefore, grateful to Mr. E. C. Andrews, B.A., Mr. James Nangle, Mr. W. M. Hamlet, F.I.C., and to Professor W. H. Warren, for delivering these lectures during the year.

Obituary.—I will now refer briefly to those of our members who, during the year, have been removed by death.

This Society did itself the honour, and at the same time expressed approval of the scientific efforts of Dr. Alfred Russel Wallace, when, in the year 1895, it elected him as one of its Honorary Members. Although 90 years old when he died, yet, his scientific life had been one long period of strenuous activity and continuity of purpose. He will perhaps be best remembered as an advocate for and co-worker with Darwin in the exposition of the cause of natural selection, and in the time to come when scientists of the next generation shall look back on the efforts of the workers of this, one of the names to be remembered with appreciation will be that of Dr. Wallace. The message he has left to us is one of encouragement, and suggestion, and we recognise that as one of the active men of his day he did his share in the forward march of scientific progress.

Dr. Critchley Hinder was elected to this Society in 1896, and although he did not take a very active part in the affairs of the Society during later years, yet, his marked ability and activity in the field of surgery brought his name prominently to the front, and in this connection he became one of the best known practitioners in Sydney, if not in the whole State. Dr. Hinder graduated with honours at the Sydney Medical School in 1889, and was one of the second batch of graduates from that school. After filling various positions as a medical man, he was, in 1894, appointed assistant honorary surgeon to the Royal Prince Alfred Hospital, an institution with which he remained actively connected, until, at the time of his death, he held the position of second on the staff of full surgeons. He was lecturer and examiner in clinical surgery in connection with the University Medical School, and a member of the Faculty of Medicine. He greatly assisted in the establishment of the Western Suburbs Cottage Hospital, and was one of the founders of the Western Suburbs Medical Society. In 1909 he was elected President of the New South Wales Branch of the British Medical Association, and was Vice-President in the section of surgery at the Australasian Medical Congresses at Adelaide and Melbourne. In many other directions he took an active part in the progress and welfare of the people, and was a citizen worthy to be remembered. His death on the 14th September—brought about through an accidental wound obtained in the course of his professional duties—removed from among us one of our most brilliant members, and from scientific surgery one of its best exponents. Dr. Hinder wrote numerous articles, and was the author of a copiously illustrated work "Lectures on Clinical Surgery," published in 1904.

Mr. J. H. Goodlet, better known perhaps as Colonel Goodlet, was elected a member of this Society as far back as 1859, and was, at the time of his death, the second oldest member. When quite a young man he took an active interest in the work of this Society, and although not a contributor to the proceedings, yet, he continued to show his appreciation of its efforts until the last. It is, however, as a philanthropist that he will be chiefly remembered, and from his large hearted benefactions many institutions in New South Wales have greatly benefitted. His practical sympathy with the sick was always in evidence, and his action in the establishment of the first home for consumptives in New South Wales, was only one example of his continuous efforts to benefit the afflicted. He was treasurer to the Sydney Female Refuge for forty years, a director of the Sydney Hospital for many years, and he also took an active part in the affairs of the Benevolent Society, as well as many others. Born in Leith, Scotland, he came to Australia when but seventeen years old, and was seventy-eight years of age at the time of his death.

Mr. Lewis Whitfeld, the well known Sydney Barrister, was elected to this Society in 1879. He was called to the Bar in 1888, and was in active practice to the last, as he appeared in Court on the morning of the day of his death. The suddeness of his death on the 28th June, when playing golf at Rose Bay, was extremely sad. He was a man highly respected, and his active assistance in the cause of scientific effort was shown by his long association with this Society.

Mr. John Plummer, who died on the 9th March, 1914, was elected a member of this Society in 1896. He was connected with journalistic effort in New South Wales for more than thirty years, and had previously been occupied with literary and statistical work in England. At one time he was sub-editor of the "Morning Advertiser," which position he relinquished to join the staff of the "Graphic." In 1879 he came to Sydney as the representative of that journal at the International Exhibition in the Garden Palace. His sympathies were always with the efforts of this Society, and with scientific work generally. He was in his eighty-fourth year at the time of his death.

Dr. C. Russell Watson, who died on the 24th January, 1914, was elected a member of this Society in 1876. For a great number of years he carried on his duties as a medical practitioner in Erskineville, near Sydney, where he gained the respect and regard of all those who came into contact with him. His many acts of kindness and his benevolent actions generally, caused him to be highly esteemed, and the district has lost a good resident as well as this Society a good member.

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The new buildings of the Institute of Tropical Medicine at Townsville, Queensland, were opened on June 28th. This institution has been established to deal specially with diseases peculiar to Northern Australia, and at the commencement of its existence was assisted by contributions from various Australian Universities. It is now supported by an annual grant of £4,000 from the Federal Government, as well as one of £500 from the Queensland Government. This is a direct recognition of the value to a country of systematic scientific research, and one might express a hope that this policy will be extended to the furtherance of research in other directions. That the results obtained by this institute may be as successful, and as advantageous to the people of Australia, as similar investigations undertaken in Africa and Central America have been to the inhabitants of those regions, is, I am sure, the wish of every member of this Society.

A research of considerable importance now being undertaken at Cobar in this State, under the direction of the Rev. Edward F. Pigot, S.J., B.A., of the Riverview College Observatory, Sydney, is the investigation of the elastic rigidity of the earth, derived from the tidal deformation of our planet by the sun and the moon. This research on the "body-tides" or "earth-tides" has been in progress in Europe for a number of years, and in the hands of more recent investigators, *e.g.*, Schweydar (Heidelberg), Orloff (Dorpat), and above all, Hecker (Potsdam), remarkable results have been obtained by horizontal pendulums of extreme sensibility, with photographic registration. The curves obtained have, however, exhibited certain anomalous secondary features, and with the view of investigating these, a Commission of the International Seismological Association was appointed. The commission is establishing research stations in Asia, Africa, North America, and Australia, in addition to the European stations already existing. The stations must be at a sufficient distance from the coast to avoid disturbing influences of the oceanic tidal wave, and for this reason Cobar was selected as the Australian station, this locality being 360 miles north-westerly of Sydney. The instruments have been installed there recently, in a disused portion of one of the mines, 430 feet below the surface so as to avoid thermal warping due to solar radiation. The registration of each station will be continued for at least two years, and the measurements and reductions will be carried out at head-quarters in Europe.

Perhaps the most momentous question which has arisen during the past year, concerning the health of the people, is the marvellous success which has attended the treatment of cancer with radium. The initial experimental stages have shown most satisfactory results, and the more that is known about the action of radium on growths of this nature, the more enthusiastic specialists become. Early this year, Dr. W. S. Lazarus-Barlow, of the Middlesex Hospital, England, made some startling statements when recounting the satisfactory results of treatment at that institution. The United States of America has shown considerable anxiety in reference to this question, and through the kindness of Mr. Radcliff, I have been able to read the reports of the inquiry on radium before the Committee of Mines and Mining (The House of Representatives) held on January 19th last. Testimony to the efficacy of radium in the treatment of cancer was given by Dr. H. A. Kelly of Baltimore ; Dr. Robert Abbe, Senior Surgeon, St. Luke's Hospital, New York City; Dr. H. R. Gaylord, Director, State Institute for Study of Malignant Disease, Buffalo ; and Dr. C. F. Burnham, Johns Hopkins Hospital, Baltimore ; who all certified to the splendid results they obtained with radium, and Dr. Kelly declared that radium was the most remarkable therapeutic agent which has ever been put into the hands of man, and that it had far greater curative effects in cancer than had been hitherto suspected. The cry was in all cases for more radium, so that even more satisfactory results might be obtained, and attempts are being made in that country to give the Government greater control over the production of radium, and to a certain extent a monopoly of all deposits of carnotite, pitchblende, or other ores containing radium in sufficient quantity for extraction, in lands belonging to the United States.

At the present time, no less than 75,000 people die annually in the United States from cancer, and if it is only possible to save ten or fifteen per cent. of these by this method, then any expenditure of money in the preparation or purchase of the necessary radium would be justified, if it could be obtained. The German Government, progressive as ever, gave last year a million marks with which to purchase radium, to be used in their teaching institutions and hospitals for public work. Important as this question must be to those countries whose populations are large, yet, it is just as important to us in Australia, as the deaths in this country from cancer are proportionate to those of other countries, and we should not be behind in the endeavour to save to the nation the lives of those who are now shown to die unnecessarily. Mr. Knibbs, the Commonwealth Statistician, informs me that the deaths from the various forms of cancer in the Commonwealth during the year 1913 numbered 3,603.

During the year one of our members, Mr. S. Radcliff, brought under the notice of the Society, and the world generally, the methods adopted by him at the works at Woolwich, near Sydney, in extracting the small amount of radium from the ore deposits at Olary, South Australia. This ore was found by European chemists to be difficult of treatment, so that buyers could not be found for it. It is thus creditable in the extreme that the possibility of profitably treating the ore locally has been shown. The success of the process adopted depends largely on the fact that it is possible to extract the radium without having to decompose the whole of the mineral constituents in the ore, and when it is considered that the material treated contains only one part of the element radium in 214 million parts of ore, it is seen how intricate the process becomes, and how carefully the manufacture must be carried on. Under such conditions as maintain in this and similar ores, it is hardly to be expected that radium will ever be cheap, although even at its present price a lot of radium could be purchased for the cost of a modern battleship.

When the mineral deposits of the little known portions of Australia shall be systematically prospected, it is very probable that more extensive deposits of radium bearing minerals will be discovered, and production thus increased. It is worthy of consideration, therefore, whether the needs of our own people are not sufficiently imperative to demand the retention in Australia of our own material, until home requirements are satisfied, even if the State finds it necessary also to undertake the manufacture of the radium itself, in order to augment the supply.

It is, however, the scientific aspect of this question which appeals more strongly to us, because we recognise that all such discoveries must result in increased stimulus to further physical and chemical researches. We are only just on the threshold of the utilisation of minute quantities of matter, and the advantages of these, both in the animal and vegetable kingdoms, will be more and more brought out as research proceeds and satisfactory results accumulate.

The Australian Antarctic Expedition under Dr. Douglas Mawson has now returned to Australia, having completed the work it set out to accomplish. This Society took advantage of the opportunity when the leader was in Sydney to tender to him a hearty welcome on his return to Australia, and the Society's rooms on that occasion were well filled by members wishing to do honour to him and to his brave companions. The forced detention of Dr. Mawson and some other members of the expedition in Antarctica for a longer period than was intended, should be the means of adding considerably to the magnitude of the scientific results obtained by the expedition generally, so that the delay may be advantageous after all. We are anxiously waiting for the further statement of these scientific results, and Dr. Mawson proposes making an announcement during the visit of the British Association in August next. Some of the general scientific results from the expedition were recorded and explained by Mr. Cambage in his Presidential Address of last year, and these indicate the extent of the observations and the efforts of the members to carry out successfully the duties allotted to them. How much Australia is likely to be advantaged by the results of the expedition will be seen later, for it must necessarily be some time, perhaps years, before all the scientific data can be systematically arranged. We must wait, therefore, for the publication of the promised volumes to see in what directions these data help towards a general scientific advance. That progress will be considerable in certain directions cannot be doubted, and the results of the labours of the members of this expedition will show that Australia is not behind in the effort to advance the scientific knowledge of the world, nor in the ability necessary to carry it out to a successful issue.

Symon's Meteorological Magazine for July, 1913, speaks eulogistically about the inclusion of the Antarctic regions within the system of daily reports, and congratulates Dr. Mawson on the realisation of what was but recently a fantastic dream.

Another matter for congratulation in connection with the progress of Antarctic Research is the approaching issue of some of the scientific results of the Shackleton Expedition. Professor T. W. Edgeworth David, F.R.S., B.A., etc., has just returned from Europe, having there completed and prepared for press the first volume of the geological reports of that expedition. I am sure we all congratulate Professor David on the completion, so far, of a work of such magnitude.

The meeting of the British Association in Australia this year is such a momentous epoch in the scientific life of this country, that every effort should be made to render the meetings to be held here in August next as successful as possible. That the British Association should have decided to hold its annual meeting in 1914 so far from the centre of the Empire, is indeed a compliment to us, and a recognition of the efforts of the scientific workers of this young country. This visit will act as a stimulus to the aspirations and ambitions of Australian scientists, and encourage them to work with renewed energy in the future. The liberal financial assistance given to this undertaking by the Federal and State Governments—described in detail in the Presidential Address of last year—is a matter for gratification on all sides. We, as a Society, are not unmindful of this generosity, and fully appreciate the help thus given. The British Association has, since its inception, done much to foster a progressive scientific spirit throughout the British Dominions, and has followed, in this particular, the policy enunciated in the preface to the first report in 1831, a paragraph in which reads as follows:—"with a just sense, therefore, of the consequences to Science of combining the Philosophical Societies dispersed throughout the provinces of the Empire in a general co-operative union." We in Australia can reciprocate the spirit of such a policy, and endeavour to do our share towards its consummation.

I take this opportunity of expressing my thanks to the Honorary Secretaries and to the Honorary Treasurer for the manner in which they have conducted the affairs of the Society during the year. It is not generally recognised how much valuable time is given by these Honorary Officers in the interest of the Society, but the preparation of the annual volume, the library management, the arrangement of the financial affairs of the Society, the correspondence and many other duties all demand considerable attention and exacting service.

In this connection, I would direct your attention to a matter of some moment to the Society. As you are aware our highly respected Honorary Secretary, Mr. J. H. Maiden, has expressed a wish to retire from that office. It is now 21 years since Mr. Maiden was first elected to the position of Honorary Secretary, and with the exceptions of the years 1896 and 1911 when he was your President, his services have been continuous. His efforts have always been willingly given to further the welfare of this Society, and his natural ability for organising and his methodical methods have enabled its affairs to proceed smoothly and efficiently. The Royal Society is under a great obligation to Mr. Maiden for his unselfish devotion to duty, and for his endeavours to increase its importance as a scientific institution. He has always been ready to help in every possible way, and we all regret that he has now ceased to hold the position of Honorary Secretary. We wish him long life, continued health, and energy. Although he retires from the office of Secretary, yet the Society will continue to have his advice and counsel in the direction of its affairs.

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I now come to the main portion of my address, and ask you to bear with me while I endeavour to explain to you some features brought out by the study of our Native Flora. I have to thank my colleague Mr. Baker for botanical advice and assistance, and my Laboratory Assistant, Mr. Randle, for the preparation of the ashes. I need hardly say that I have taken full advantage of the resources of the Technological Museum.

The value of the chemical factor in the study of Plants.

When choosing the subject for this address it appeared to me that the time was opportune to review the results so far obtained from the phytochemical investigations which have formed the principal portion of the research work of the Technological Museum during recent years, and endeavour to show in what directions these data appear to assist the establishment of broad generalisations, the correct understanding of which would go far towards securing important economic results.

It is now more than twenty years since my colleague (Mr. R. T. Baker, F.L.S.) and I first commenced our joint investigations into the economic possibilities and scientific characters of certain groups of the indigenous flora of this continent, a study which has been continued to the present time. During this period, the chief botanical and chemical features—more or less complete—of about 160 distinct species of Eucalyptus have been collaterally determined, while practically the whole of the coniferous trees of Australia have been similarly treated. Besides these larger systematic investigations many species of Melaleuca, growing in eastern Australia, have been worked in a corresponding manner, as well as several other species belonging to different genera.

A considerable amount of general evidence in a new direction has thus been collected, the consideration of which should make it possible to offer some reasonable suggestions as to the manner in which certain chemical phenomena appear to have influenced the botanical characters of some of these plants, or at least, to have become in contemporaneous agreement with those morphological distinctions which go to differentiate the several species in the larger Australian genera.

It might perhaps be accepted that real insight into the constructive unity of the plant would be more satisfactorily obtained from the consideration of results derived from separate lines of investigation, and no objection can now be taken to the conclusions arrived at from specialised effort in any direction, so long as it assists the object in view. Botanical science already relies upon the efforts of workers in many sections, such as those of morphology, anatomy, cytology, physiology, and ecology, all these being in co-operation with the systematic side. But it is now shown that some of these sections are particularly dependent upon the results of chemical reactions, the principal effect of which may be observed in well defined botanical changes, these eventually becoming quite distinctive in character, and as such are now recognised.

The time absorbing and exacting nature of extensive chemical investigations in directions sufficiently comprehensive to enable generalisations to be undertaken, is, perhaps, one reason why some biologists have, in the past, not always been prepared to take advantage of such evidence as is to be derived from extended chemical studies carried out in parallel directions with their own, and on the same or similar material. If the results of the chemical work with the principal Australian genera have been helpful to my botanical colleague, certainly his investigations on the same material have greatly assisted my conclusions. This co-operation necessarily broadened the outlook in both directions and offered considerable advantages to thought and suggestion, while enabling a deeper insight to be obtained into some of the problems underlying the evolutionary formation of these genera and of their peculiarities of distribution.

The demonstrated results of life effort are now recognised as being largely due to chemical action, and extended investigations of the chemical and physical causes which are responsible for these changes would throw considerable light on the metabolic processes of the plant, the value of the results being, of course, governed largely by the extent of the observations, and on the completeness with which they have been undertaken.

Professor Vines has admitted that in studying the differentiation of the cell wall the botanist received valuable aid from the chemist, and research in this direction probably began with Payen's discovery that the characteristic and primary chemical constituent of the cell wall is a carbohydrate which he termed cellulose. This is only one of numerous instances of appreciation; but it is to the slow accumulation of isolated chemical facts such as this, that we may hope to arrive at more definite conclusions as to the chemical reactions by which pronounced anabolic changes are brought about, and the directions in which the substances thus formed are utilised.

Darwin was evidently convinced that chemical conditions influence greatly the growth and characterisation of plants, because in the first chapter of the Origin of Species he writes:—"such facts as the complex and extraordinary out-growths which variably follow from the insertion of a minute drop of poison by a gall producing insect, show us what singular modifications might result in the case of plants from a chemical change in the nature of the sap."

It would be possible, of course, to multiply references of a similar nature, but these are sufficient to indicate the opinions of workers generally on the effect of chemical influences in the establishment of natural floras.

In dealing with genera of economic importance it is, of course, the utilitarian side of the question which dominates, and commercial progress must be advantaged when proper value is attached to the results of chemical work, if this is able to supply the evidence required. Morphological characters are not always sufficiently distinctive to enable important differences to be determined, and with certain genera discrimination is difficult between species the botanical features of which have very much in common. For instance, one species may yield in quantity a substance which has, or may have, considerable economic importance, while another species, thought perhaps by some to be identical with it, has no economic possibilities in a similar direction. If these distinctive peculiarities are eventually found to be definite throughout the whole extent of the distribution of the species, then such a constancy of specific character, in this direction, is shown, that it becomes desirable to investigate more deeply the morphological and other features, so that these may be arranged in agreement with the combined botanical and chemical evidence. When examined under such a suggestion it may be expected that differences which originally appeared not to be particularly worthy of notice for specific purposes, would become well defined characteristics, and thus allow discrimination between them to be easily made. Such has been our experiences during the investigations, so far undertaken with the Melaleucas, the Callitris and the Eucalypts.

Melaleuca genistifolia and its allied species will furnish one illustration in support. *M. genistifolia* was first described by Dr. Smith in 1776. In 1858 Baron von Mueller named a species *M. bracteata*, which tree has botanical characters somewhat closely resembling *M. genistifolia*. Bentham certainly thought so, because in the Flora Australiensis he there synonymised them. The chemical evidence is conclusive that the two trees are quite distinct, so much so, that all doubts are now set at rest, and the botanical differences which Mueller saw are now shown to be distinctive. The essential oils obtained from the leaves by steam distillation are alone sufficient for the purpose, as these are distinctly different in the two trees, that from *M. genistifolia* has no possible commercial value, as it consists very largely of pinene, between 80 and 90 per cent. of the oil being that constituent, and it does not appear to contain in any degree the characteristic constituent of the oil of the other species. The oil of *M. bracteata* consists very largely of methyl-eugenol—a constituent heavier than water—while the very small amount of terpene present is phellandrene. The oil also contains a small amount of an ester of cinnamic acid, a little cinnamic aldehyde, and some eugenol. None of these constituents occur in the oil of *M. genistifolia.* Surely these two plants must be distinct. The yield from *M. bracteata* is about one per cent., so that it produces an oil containing methyl-eugenol in larger amount than is obtainable from the leaves of any other known plant. Since the first results were published the Technological Museum has received material of *M. bracteata* from Kinbombi in Queensland, hundreds of miles from the previous locality. The oil from this material was identical in character with that from New South Wales, showing the constant nature of this chemical character. If the time ever came when it might be desirable to cultivate *M. bracteata* for its oil, it would not do to substitute *M. genistifolia*, the closely agreeing botanical characters notwithstanding.

The correct position of *M. trichostachya* with that of *M. linariifolia* has also been decided in a similar manner. The leaf oil of *M. trichostachya* is rich in cineol and the species may thus eventually be of some commercial importance, but *M. linariifolia* has no economic value in a like direction.

Differences of a like nature are even more strongly emphasised with the several species agreeing somewhat in botanical features with *M. leucadendron.*

When these chemical characters have been definitely determined, botanical differences often appear more distinctly marked, so that specific features are not likely to be again mistaken.

The acceptance of such economic influence towards discrimination does not in any way detract from the value of specialisation in the higher branches of botanical science, for indeed it must rather be considered as helpful, suggesting perhaps the existence of peculiar conditions, in certain directions, which previously were indifferently noticed or not understood.

A scientific discovery often has immediately a commercial value, but while the latter is, from a scientific point of view, subordinate to the former, yet, the study from the economic side often gives the necessary stimulus to effort, and promotes activity in the endeavour to solve the more scientific problems, often with the idea that the result may ultimately be of monetary value. Many of the facts of theoretical science have been the outcome of economic work, and have often been suggested from the practical side. This suggestion has been demonstrated over and over again during the remarkable progress which has taken place in specialised organic chemistry during the last fifty years, and many of the laws governing constitution and construction of organic compounds have been the outcome of effort directed by economic considerations. Is it not then to be expected that chemical laws governing the growth of, and the formation of plant constituents, as well as those which lead to special peculiarities, will be discovered in a similar way, when economic considerations require that the subject shall be studied with that care, skill and perseverance which have made modern organic chemistry such a splendid consummation?

It is, perhaps, to be regretted that the prosecution of pure science, in many directions, is now so largely dependent upon the commercial aspect, and that the idea of carrying on scientific work for the pure love of it, regardless of all monetary considerations, is so rapidly becoming obsolete. But nevertheless whatever may be the stimulus to scientific effort the results are the same, and all tend, in one direction or another, to the betterment of human conditions.

In Australia the circumstances are such that the tendency is to devote larger effort to the investigation and discrimination of economic material; but even so, the opportunity for deeper study is also present, and it is desirable that the relations of trees to their environment, the influences which have enabled certain forms to survive adverse conditions, the development of species and distribution of particular genera, and the reasons for predominance of certain structural characters, so pronounced throughout the members of some groups, should be more deeply investigated. It is upon the results of experimental work that we may hope to establish these broader generalisations, and in this direction those from chemical research would be perhaps the most helpful. The discrimination between species alone, if this be the object of the work, may be considered as the least valuable of all these investigations, as such decisions, when so restricted, do not enable us to understand the general causes which have been responsible for generic structural differences.

The work so far carried out in this way with the *Callitris* of Australia has added to the knowledge of the general characters of the group, and this result was largely made possible by the co-ordination of the results of both botanical and chemical investigations. The peculiarities of the genus were thus more completely indicated, and the contemporaneous alterations, both in botanical features and chemical constituents, could thus be followed throughout the series.

In the foliage of *Callitris spp.* the secretion of essential oil takes place in one or more pockets hidden in the summit towards the free ends of the adnate decurrent leaves, and in the numerous sections observed the secretion glands show no passage to the outer air. It thus appears that with the *Callitris* there is no exhalation of the essential oil product, this apparently being utilised by the plant in other ways. Although the oil constituents vary considerably in the various species, yet, these are comparatively constant for each, and it does not matter how extensive is their natural geographical distribution the results are the same. The yield of oil for each species is also fairly constant, indicating also a uniformity in secretion. The formation of the alcohols borneol and geraniol in the oils of the *Callitris* is also in a uniform direction. In those species which, perhaps, constitute the oldest members of the genus now living in Australia, the greater portion of the ester consists of bornyl-acetate, but as the genus evolved, the latter ester increased in amount until in the oils of certain species growing on the extreme eastern portion of the continent, and in Tasmania, it had entirely supplanted the bornyl-acetate, and at the same time had increased in percentage amount. By analysis it was possible to follow the diminution of the one ester, and the corresponding increase of the other, and also to show that when the bornyl-acetate had been quite supplanted that the free alcohol was entirely geraniol. As the chemical characters changed the botanical features altered in agreement.

The comparative constancy of individual species, in both botanical and chemical directions, is so definite that there is little fear that subsequent investigations will upset conclusions based on evidence of this nature, but rather that further study will demonstrate more completely the indications of divergence so obtained.

Whatever may be the object of the plant in the formation of these particular essential oil constituents, it seems evident that definite lines of molecular arrangement are followed, and it is possible that the formation of these characteristic constituents is a part of the economy of the plant, leading to the completion of the metabolic processes of the particular species in which they occur. It thus appears that the influences directing the formation of these chemical products are practically constant, even under diverse conditions of natural growth, so that the products thus formed have a discriminative value and bear a constant relation to other structural characteristics of the plant. This chemical feature thus becomes really of morphological value, as much perhaps as either a fruit or a bud, although the identification is more subtle, and it is of course, less easily available for observation.

It would be well if the chemical characters of the closely related genera of Africa, *Tetraclinis* of the north, and *Widdringtonia* of the south, were determined so that the origin and method of distribution of these, together with *Callitris*, might be more satisfactorily followed.

Dr. Henry has shown that the sandarac resins of *Callitris* and of *Tetraclinis* are similar, but more complete investigation with the exudations of all the species of the three genera would probably show a gradation in the percentage amounts of the chief resin acids or resinoids, the arrangement of which in proper sequence—together with the determination of their leaf oil constituents—would probably assist greatly their classification. The leaf oils of *Tetraclinis* and of *Widdringtonia* have not so far been chemically determined, so that comparison in this direction with those of *Callitris* cannot yet be made. The knowledge of the identity of the predominant terpene in these African oils, together with that of the composition of their esters, whether bornyl- or geranyl-acetates, would probably assist towards suggesting a theory to account for the territorial distribution of the three genera. That they are very old seems conclusive, and that they were originally distributed over land connections now no longer in evidence seems also a reasonable conclusion.

Professor Saxton, from his studies with *Tetraclinis*, recently published in the Annals of Botany, thinks that the southern sub-family *Callitroideæ* were derived from the essentially northern sub-family *Cupressoideæ*, and from the available evidence suggests the former existence of a great Antarctic continent with a land connection between Southern Africa and southern Australia.

It will probably be found that pinene was the earliest terpene in the leaf oils of these sections of the Conifereæ, and that the other terpenes and oxygen bearing compounds developed later. Such a result would be in agreement with those already obtained with some other large and ancient genera.

The most important result so far derived from the phyto-chemical studies with the genus Eucalyptus, and the closely related genus Angophora, is, perhaps, the intimate connection shown to exist between the leaf venations of the mature lanceolate leaves of the several species and their essential oil constituents. This striking correlation enabled suggestions to be formulated, particularly in respect to Eucalyptus species with closely agreeing characters, which when followed up led to a more intimate acquaintance with the genus, and, perhaps, has also been the means of stimulating research by workers in other directions, with very gratifying results. This frequently recurring agreement between the salient points, both botanically and chemically, appeared to point to important functional characteristics, so that it has been possible to suggest, with perhaps more than a degree of probability, the line of descent followed during the evolution of this most extensive Australian genus.

The comparative constancy of chemical constituents in the products of individual species—essential oil, astringent exudation, tannin, etc., suggests the idea that each species acts as if it were a chemical factory, manufacturing particular chemical constituents, under natural conditions, according to a specific formula. What these conditions of formation are it should be our endeavour to determine. It does not matter how extensive the distribution of the species, the chemical constituents are still in agreement, and this has been found to be the case with members of the same species growing both in Tasmania and on the mainland, districts hundreds of miles apart. These agreeing results seem to suggest that the establishment of the species itself is largely governed by the chemical requirements of the tree, particularly in its earlier stages. If the conditions of growth still remain in conformity with original factors the species continue, generation after generation to repeat, in every detail, both the botanical and chemical features characteristic of the tree. This has been well demonstrated with several Eucalyptus species common to both Australia and Tasmania, which were evidently quite definitely fixed long before Tasmania was separated from the mainland, a period sufficiently long for some species peculiar to the island to have definitely established themselves. Available evidence also indicates that a few species have found conditions of separation not so congenial, the struggle to overcome certain adverse conditions having brought about changes not difficult to trace. Here we have, now proceeding, perhaps, evidences of the influences which in the dim past have largely been responsible for the original establishment of the numerous species and groups of the genus, which have thus become not only divergent but progressive.

It seems then not unreasonable to consider that if sufficient time were allowed for the completion of the changes now proceeding that the several groups of the genus Eucalyptus, as we know them to-day, would eventually establish themselves as new genera of the Myrtaceæ.

Hooker, in his Flora of Tasmania, evidently felt a difficulty in discrimination, because, when writing from the botanical standpoint, he says, "that it is much easier to see peculiarities than to appreciate resemblances, and that important general characters which pervade all the members of a family or flora are too often overlooked or undervalued."

To assist in the endeavour to attach their true value to these important general characters of the genus Eucalyptus is, I am sure, the ambition of all workers upon these scientifically interesting and economically valuable trees.

The genus Angophora furnishes considerable evidence, both botanically and chemically, in the direction of showing that the *Corymboseœ* is perhaps, the oldest of the many groups into which the genus Eucalyptus divides itself. The venation of the mature lanceolate leaves is the same, the chemical constituents of the essential oils are similar, the exudations are in agreement, and the general morphological features have strong resemblances, excepting, of course, the important character of the Eucalypts, the operculum.

The genus Angophora is probably a very old and perhaps a decaying one, and originally may have had a much more extensive distribution in Australia. It does not appear to have had the power to adapt itself generally to the changing conditions of soil and climate in the same way that Eucalyptus had, and this is illustrated by the fact that the leaf oils of the Angophoras are all practically identical in composition, while the exudations of the species are also similar. The principal terpene in these oils is pinene, and this has an identical specific rotation in all the species, a constancy so very different from that found in Eucalyptus. The ester is geranyl-acetate and this also occurs in very many species of Eucalyptus, reaching a maximum in *E. Macarthuri.*

These results taken together seem to indicate that the constituents of the oils of the earlier members of the genus Eucalyptus had their origin in those of the genus Angophora if not in a still older one.

From the *Corymboseæ* group the genus Eucalyptus evolved in various directions, and to enable the conditions adverse to distribution to be overcome, both the botanical features and chemical characters underwent considerable changes. The mature lanceolate leaves altered considerably the disposition of their veins, denoting eventually the presence of eucalyptol (cineol) in their oils, or of that of the terpene phellandrene in those of the more recent species. The form and structure of their anthers and of their seedlings changed in agreement. The appearance of their barks became more diverse, and distinct groups were established considered on a cortical classification; while the texture, hardness and general characters of the woods of the several groups varied considerably. The tannins and astringent exudations are also shown to have been correspondingly under the influences of the factors which were instrumental in bringing about changes in the genus; constituents characteristic of the exudations of earlier members continue for a time and then are found no more, while even the tannin in the members of the later groups is not the same substance as that in the earlier.

These distinctive changes, which can now be somewhat readily followed, suggest the evolutionary formation of the several species and groups. The extended period which must have elapsed before the species succeeded in reaching such definiteness in general features, indicates also a considerable age for the genus, and suggests the probability that these changes have been by slow and almost imperceptible stages.

The evidences which have so far accumulated appear to point to chemical influences being largely the direct cause of these distinctive changes, and our knowledge of the groups would be greatly advanced if it were possible to discover the mechanism of these chemical reactions. That they are physiological in effect is evident, and it is to the results of extended study in this branch of science that we may hope to understand more and more those complex chemical reactions, ever at work building up distinct organic material from very simple substances.

The results of Plant Metabolism are, perhaps, more often considered as directly traceable to the effects of organic influences, than to those in which inorganic constituents appear to play a more important part. It may even be suggested that the deeper consideration of these latter processes has so far been neglected; certainly this is so in comparison with those studies carried out from the strictly organic side. It is generally recognised, however, that the available food of plants is intimately associated with the presence of certain elements, and metabolism does not appear to be able to proceed satisfactorily without their assistance.

The methods whereby these inorganic elements—often present in most minute quantities—are able to assist in the synthetic production of these complex organic bodies are certainly not understood, and the presence of manganese for instance, in small amounts in all the species of Callitris and Eucalyptus growing in Australia, does not suggest that this element, at all events, is there by accident. If it were possible to follow this substance through all its ramifications in the tree it would probably be found to be in unstable association, and a necessary factor in the production of more stable substances, if not even largely responsible for the very existence of the plant itself.

Professor Bertrand, in an address before the International Congress of Applied Chemistry, discussed the role played by traces only of chemical substances in biological chemistry. He pointed out that besides the three or four elements which it is generally recognised go to form plant substances, there may be more than thirty other elements which may be detected in the plant in minute proportions, even to less than one 100,000th of the plant's weight, but which play an important part in the life of the plant and in its development. As will be shown later with certain of the Eucalypts this minuteness may extend to less than one in a million parts of anhydrous timber.

It may be that the correct application of these minute quantities of mineral substances, which probably act as catalysts, would result in enormous economic advantages in production, and lead to increased formation in the plant of what at present are but rare and costly commodities.

The discovery of radium and its influences on plant growth has stimulated enquiry in corresponding directions, and Stocklasa has shown that both uranium and lead nitrates, in small proportions, definitely augment vegetable growth and production, although having less influence than radium itself. The literature in regard to this subject of inorganic influence on plants is now somewhat extensive, from a perusal of which it may be seen that a considerable number of the so-called rarer elements have at one time or another been detected as occurring in plants, as well as minute quantities of such common elements as copper, zinc, barium, etc. In one species of Eucalyptus copper was detected; this was found in the ash of the timber of the "Ironbark" *E. sideroxylon*, growing at Condobolin, and was separated in the metallic form. The general map published by the Mines Department does not include Condobolin in the cupriferous districts of New South Wales, but there is now no doubt but that copper does occur in that district as indicated by this Eucalyptus.[1]

The repeated occurrence of manganese in the ash of the wood of the Australian Callitris led to an extended study as to position, and it was found that this element occurs in all parts of the plant; seeds, seed cases, leaves, bark, as well as in the timber, but always in minute proportion. As the manganese is found in the ashes of all the species of Callitris it is reasonable to suppose that its presence is essential to the satisfactory growth of these trees, and is perhaps, as important in this connection as either potassium or phosphorus.

These results with the Callitris led to further inquiry in the same direction with the other extensive Australian genus—Eucalyptus. So far as investigation has proceeded it is shown that manganese is also a constant constituent in the ash of all the species of this genus, and further, that there is a remarkable uniformity between the percentage amounts of manganese in the ash of the several species belonging to the same group, and that this is irrespective of the location where the trees grow, even if these are hundreds of miles apart. It appears, therefore, that the uniformity in the amounts of this necessary food material, taken in conjunction, perhaps, with other ash constituents,

[1] Since the above was written Mr. Cambage informs me that leases have been granted near Condobolin to the north, for working copper, etc., indicated in Map Sheet 9 of the Mining Districts of New South Wales.

may be connected in some way with the original establishment of the particular form and structure of the distinctive features which are characteristic of the species or group.

The amount of manganese in the ashes of the timbers of all the species of the "Ironbarks" tested was in remarkable agreement, ranging from 1·5 per cent. in those of *E. crebra* and *E. melanophloia* to 1·15 per cent. in that of *E. sideroxylon*. If the presence of this element were an accident due to location of growth then there could not be this uniformity in percentage amount, and the presence of manganese in the soil in varying quantities may be thus a contributing factor to the distribution of these particular species. It is apparent, however, that manganese is a very widely distributed substance, for besides being found in all species of Callitris it most probably occurs in every species of Eucalyptus, and members of this genus extend over the greater portion of Australia.

Those Eucalyptus trees which grow on the higher and poorer lands appear to contain less manganese in their ash than those which require a soil richer in ordinary mineral plant food, and this again may account somewhat for the position where certain Eucalyptus species grow.

This question of the natural distribution of the Eucalypts is one which has had particular interest for scientists for a long time. It may be, however, that species location is more largely due to chemical influences, and as our knowledge extends in this direction it may be possible to give, eventually, a satisfactory explanation as to why certain species of Eucalyptus, under natural conditions, grow luxuriantly in one place but not in another.

Mr. Cambage in his Presidential Address of last year brought forward considerable data, which added to our knowledge regarding this question of Eucalyptus distribution, and directed attention to the influences certain soils appear to have on the location of members of the genus.

Dr. Cuthbert Hall informs me that he has experienced great difficulty with the seedlings of *E. fastigata*, *E. dextropinea*, and a few other species, and that he has been unable to grow the seedlings of these species beyond the second leaf stage, as with a very few exceptions they then all died, the soil apparently not being suitable.

It is not possible, of course, to know the real extent of these influences until the chemistry of the species in its relation to the soil, on which it grows naturally, shall have been fully determined. Although the soil and its constituents exert the chief influences upon the natural distribution of species, yet, altitude or climate, seems to be a contributing factor also. The conditions directing these influences are, however, at present very imperfectly understood, and it may be that one set of factors is the corollary of the other, both acting along parallel lines.

The marked differences in the characters and amounts of inorganic constituents which appear to be necessary to the natural growth of the different species, or rather groups of Eucalypts, arrests one's attention; particularly when it is seen that there is roughly a relative constancy in requirements with certain elements with the members of each group. This unconformity in mineral constituents with species belonging to different groups, but growing in close proximity to each other, seems to indicate that the solvent action of the roots of the several species is not of a uniform character, or else that certain of the mineral substances dissolved have a poisonous action upon some species, although necessary to the growth of others. Magnesium appears to be a necessary constituent for the growth of all species of Eucalyptus, and is one of the principal mineral constituents in the ashes of some of them. On the other hand calcium does not seem to be in such demand by the members of certain groups, although it is found in great quantity in the ashes of species belonging to some others, particularly those of the typical "Boxes," (See Table II). Phosphorus is always present, although in certain species or groups it is in comparatively small amount, while in the ashes of all the "Stringybarks" and allied groups alumina was always detected, as well as a small amount of iron. Potassium was, of course, always present, although very small in amount in some species, as well as varying quantities of sulphur, and in some cases chlorine and sodium. The alkalis are more pronounced in the ashes of those species in which calcium is less abundant, and the largest percentages of phosphorus are found there also.

A considerable number of Eucalypts, particularly those belonging to the groups in which calcium is a pronounced constituent, construct oxalic acid as one of the products of metabolism. In some species the oxalic acid is often produced in such abundance that in some cases as much as one-sixth of the air dried bark consists eventually of calcium oxalate. These species, however, are usually of small size, often occurring in the shrubby or "Mallee" form. It is hardly to be supposed that such Eucalypts would live long enough to enable them to grow into very large trees, so that the largest Eucalypts of Australia can hardly belong to groups the members of which are subjected to such adverse chemical influences. The gigantic Eucalyptus trees of this continent, as, for instance, those belonging to such species as *E. regnans*, *E. pilularis*, *E. Delegatensis*, *E. obliqua*, etc., only use calcium in comparatively small quantities, while magnesium is an important mineral constituent in these trees. Species belonging to such groups do not, under ordinary circumstances, form oxalic acid in excess, nor other poisonous constituent, so that it is not unreasonable to assume, that under the most favourable conditions these Eucalypts could continue to construct their woody tissue for thousands of years. That these species are, however, easily susceptible to the effect of constructive poisons is indicated by the destructive effects of *Loranthus* when this parasite takes possession. A few years ago some fine trees of "Blackbutt" *E. pilularis* were growing in the neighbourhood of the Marrickville Railway Station. They became badly infected by the "Mistletoe" *Loranthus sp.*, and after a time first one and then another died, until all were eventually destroyed. This result is, in certain localities, not an uncommon occurrence with the Eucalypts.

It is, perhaps, largely due to the composition of the soil upon which these little ash-giving species choose to grow, and the comparatively small amount of the necessary mineral food available in like situations, that these particular Eucalypts have acquired the power of almost dispensing with the necessity of storing mineral material in the trunk of the tree, perhaps with the object of not depriving the leaf portion of the required mineral food supply. It can be readily calculated how large an amount of mineral matter would be stowed away in the trunks of these enormous Eucalyptus trees, if the percentage was as large as that found in the timbers of the smaller trees of some other groups. The giant trees of *E. regnans* growing in the Gippsland Ranges of Victoria are cases in point. These trees are sometimes over 70 feet in circumference, and nearly 400 feet in height. A sample of the timber from a smaller tree of this species from near Warburton in Victoria gave only 0·054 per cent. of ash, calculated on the anhydrous wood, so that a ton of this wood, when freed from moisture, only contained one pound three ounces of mineral substances. This result is quite in agreement with the ash contents of the timbers of other species belonging to this and closely associated groups, so that it may be assumed, from these data, that the largest trees of this species of Eucalyptus only store up mineral matter in their timbers to the extent of about one pound to 2,000 pounds of anhydrous wood. Taking the percentage result of mineral substances as determined in the ash of *E. regnans* as fairly representative, it will be seen, from the figures tabulated further on, that the amount of lime (CaO) in the timbers of these big trees would only be about one 15,000th part of the weight of the timber when calculated free from moisture. Although the amount of magnesia (MgO) is somewhat greater, yet, even this constituent only represents about one 10,000th part of the weight of the anhydrous wood.

It has been stated previously that manganese is a constant constituent in the Eucalypts generally, and it thus appears to be essential to the growth of these trees. The amount of manganese in the ash of the timber of *E. regnans* was only 0·274 per cent., so that this element only represents one part in 676,000 parts of the anhydrous wood. The leaves of *E. regnans*, however, gave 2·85 per cent. of ash, this being in agreement with the amount obtained with the leaves of allied species.

A Eucalyptus which often grows to a very large size in Eastern Australia is the "Blackbutt" *E. pilularis*. One of the local sights at Bulli in New South Wales is the big tree of this species which is growing near that place. It has a circumference of 59 feet, and is about 280 feet high. It is not difficult to suggest the distribution of mineral constituents in this tree also, as considerable data have been obtained from the timbers, as well as other portions of representative trees of this species. This material was collected from trees growing at the following widely distributed localities, Ashfield, Thirlmere, Ulladulla, North Coast New South Wales, and Marrickville (two specimens). This species has been chosen for more extended investigation because it is a good representative Eucalypt in New

South Wales, and complete material could readily be obtained in the immediate neighbourhood of Sydney, although any other closely related species would, no doubt have served the purpose as well. The comparative constancy of the results with the mineral constituents in this species is remarkable, and it is evident that some directing influence must be responsible for this similarity in amount of mineral contents of trees of one species growing at localities so far apart.

The highest ash content in the timbers of this species tested was 0·088 per cent. of the anhydrous wood. This was obtained from a tree growing at Marrickville (tree No. 1). The lowest amount was 0·029 per cent. from a commercial specimen from the North Coast, the next being 0·037 per cent. from another Marrickville specimen (tree No. 2). The mean of the six samples from the above localities was 0·0518 per cent. of ash, or one ton of the timber of this species would only contain about 1 ℔. 2½ ounces of mineral matter. From these agreeing results it may be expected that the big tree of *E. pilularis* above mentioned will also be in agreement, and that the anhydrous wood of its trunk probably only contains about one 15,000th part by weight of lime (CaO) and one 30,000th part of magnesia (MgO), while the manganese will only represent one part in about 900,000 parts by weight of the timber.

It seems difficult to understand in what manner such minute portions of mineral substances could assist construction, if not largely catalytic. The results with two distinct trees of *E. pilularis* growing on the sandstone formation at Marrickville show, however, that trees which contain only about 0·05 per cent. of total ash in the wood have almost 3 per cent. of mineral matter in their leaves, while the buds and petioles contain about 3·8 per cent. The constituents of the ash of the leaves are in much the same ratio as in that of the wood, but the total quantity is nearly 60 times as much. The manganese is also in larger amount in the ash of the leaves. The two specimens of *E. pilularis* from Marrickville were both in good condition and perfectly sound. No. 1 was growing at the foot of the sandstone cliffs, the other (No. 2) on the top of the hill beyond Cook's River. The manganese might thus be more readily available to No. 1, owing to its position of growth, than to the other. The results suggest that this is so, because the manganese is consistent in this direction with all parts of the trees. The top of the sandstone hills around Sydney could hardly be more unpromising for the presence of manganese, yet, the Eucalypts manage to find and use it.

The results here tabulated are too uniform in character to permit the assumption that the minute quantities of manganese are not essential to successful growth. The closely agreeing percentages of manganese in the ashes of all the timbers of *E. pilularis* tested, are of such a nature that the idea of accidental inclusion can hardly be admitted.

The uniformity which is shown to exist between the ash contents of the leaves and buds, as well as in that of the timbers of *E. pilularis*, and other species, indicate that these amounts can hardly be accidental, and the whole arrangement may be looked upon as nature's method for making the most of the available mineral food supplies. The leaves would naturally fall to the ground in time, so that the mineral substances they contain would be again available for use, but if the same percentage amount had been stored in the woody portions of trees, which might, perhaps, live on for thousands of years, too large an amount of the limited supply would have been withdrawn, and this would naturally lead to exhaustion. It may, therefore, be considered that the small amount of ash in the timber of those groups associated with *E. pilularis* is the least possible upon which these trees can continue to live and thrive. What necessary function the inorganic matter plays in the development of cellulose, as well as in other natural colloidal substances is not known, but that it is incidental to the vital processes of the plant can hardly be doubted. More complete and extended studies in colloidal chemistry, and a knowledge of the influences exerted by the enzymes, or organic catalysts, when considered with those of inorganic origin, would, no doubt, do much to solve many of the problems so closely connected with the phenomena of vegetable life.

The table (No. 1) gives the percentages and parts of ash and manganese in the portions of the trees treated. The species include representatives of the several groups into which the genus Eucalyptus naturally divides itself. The results show that the inorganic portions of the groups of trees are somewhat constant in character, and agree closely in this respect with the organic chemical constituents of the various species of Eucalyptus. Perhaps it is for this reason that the organic chemical characters are of such a constant nature.

It will be observed that the similarity existing between the members of the "Ironbark" group, for instance, and between those of the "Boxes" is not peculiar, and that the two "Stringybarks," *E. macrorrhyncha* and *E. eugenioides* also show agreeing results, while *E. obliqua* is more in conformity with *E. Delegatensis* and *E. regnans*, this being in agreement with the botanical evidence. *E. botryoides* is also shown to differ somewhat from *E. saligna*, while the two "Peppermints" *E. amygdalina* and *E. dives* are in accord. The figures also indicate that of the "Ironbarks," *E. crebra* would prefer to grow on land less rich in available basic mineral food material than would appear to be necessary for some of the other members of this group.

E. sideroxylon approaches *E. crebra* in this respect while *E. paniculata* would appear to require good land similar to that chosen by the members of the "Box" group. The presence of manganese in the soil is essential for all, and it may appear remarkable perhaps that no matter whether the percentages of the total mineral substances in the timbers of the "Ironbarks" be great or small the percentage of manganese in the ash is practically the same with all of them. The indication is that the "Boxes" also, as well as the other groups will also show agreement in this respect when complete data shall be available.

Table No. I.

	Percentage of Ash in anhydrous material.	Percentage of Manganese in ash	One part of ash in parts anhydrous material	One part of Mn in parts ash	One part Manganese in parts anhydrous material
E. pilularis					
(wood) Thirlmere ...	0·051	0·200	1960	500	980,000
,, Ashfield ...	0·065	0·200	1538	500	769,000
,, Ulladulla ...	0·041	0·260	2438	385	938,630
,, North Coast	0·029	0·210	3448	476	1,641,248
,, Marrickville No. 1 tree	0·088	0·220	1136	455	516,880
,, No. 2 tree	0·037	0·200	2703	500	1,351,500
Mean of above calculated from the ash and manganese percentages.	0·0518	0·215	1930	465	897,450
E. pilularis					
(leaves) Marrickville No. 1 tree	2·91	1·5	34	67	2,278
,, No. 2 tree	2·69	0·25	37	400	14,800
(buds with petioles) No. 1 tree	3·79	1·33	26	75	1,950
,, No. 2 tree	3·786	0·233	26	430	11,180
(seed cases = fruits) No. 2 tree	2·893	0·15	35	667	23,345
(seeds) No. 2 tree ...	1·044	0·316	96	317	30,432
E. regnans					
(wood) Warburton, Victoria	0·054	0·274	1852	365	675,980
(leaves) ditto	2·851	0·666	35	150	5,250
E. macrorrhyncha					
(wood) Woodlands	0·072	0·733	1390	136	189,040

Table No. I—*continued.*

	Percentage of Ash in anhydrous material.	Percentage of Manganese in ash	One part of ash in parts anhydrous material.	One part of Mn in parts ash.	One part Manganese in parts anhydrous material.
E. eugenioides					
(wood) Ilford ...	0·075	0·766	1333	130	173,290
E. obliqua					
(wood) Monga ...	0·025	0·22	4000	455	1,820,000
E. Delegatensis					
(wood) Laurel Hill	0·038	0·30	2632	333	876,456
E. amygdalina					
(wood) Moss Vale...	0·033	0·666	3030	150	454,500
(leaves) Braidwood	3·852	0·633	26	158	4,108
E. dives (wood) Rydal	0·059	0·50	1695	200	339,000
E. botryoides					
(wood) Belmore ...	0·152	0·833	658	120	78,960
,, Milton ...	0·132	0·60	758	166	125,828
E. saligna					
(wood) Newcastle ...	0·08	0·60	1250	166	207,500
,, commercial sample	0·045	0·733	2222	136	302,192
E. goniocalyx					
(wood) Delegate R.	0·137	0·333	730	300	219,000
E. maculata					
(wood) Cooloongolook	1·56	0·76	64	132	8,448
E. Smithii					
(wood) Hill Top ...	0·482	0·90	208	111	23,088
E. hemiphloia					
(wood) Belmore ...	1·79	0·25	56	400	22,400
E. Woollsiana					
(wood) Cobar ...	0·716	0·50	140	200	28,000
E. albens					
(wood) Grenfell ...	0·476	0·50	202	200	40,400
E. melliodora					
(wood) Colombo ...	0·552	0·583	181	171	30,951
E. viminalis					
(wood) Tasmania ...	0·161	0·833	621	120	74,520
,, Black Mountn	0·418	0·566	239	177	42,303
E. microcorys					
(wood) Dunoon ...	0·582	0·20	172	500	86,000
E. paniculata					
(wood) Newcastle ...	0·477	1·40	210	71	14,910
,, Stroud ...	0·348	1·33	288	75	21,600
E. siderophloia					
(wood) Thirlmere ...	0·170	1·25	588	80	47,040
E. melanophloia					
(wood) Narrabri ...	0·172	1·50	582	67	38,994
E. sideroxylon					
(wood) Condobolin	0·072	1·15	1390	87	120,930
E. crebra					
(wood) Thirlmere ...	0·060	1·50	1667	67	111,689

The Table No. II gives the percentages of phosphoric acid, lime, and magnesia, in the ashes of a few representative species of distinct groups of Eucalypts. It was a difficult matter to completely burn the woods of the little-lime-containing species, like *E. macrorrhyncha*, *E. pilularis*, etc., as the ash was so readily fusible, this being due to the large amount of potash and other alkalis present. It might be thought, therefore, that these species would produce an abundance of potassium carbonate when burned, but unfortunately the total mineral contents in their timbers is remarkably small, as can be seen from Table I. With the "Boxes" the ash is almost entirely lime, with little magnesia, and there seems to be a remarkable agreement in this respect with species of the several groups which have closely agreeing botanical characters. It is in the members of this group, particularly the species which contain the aldehyde aromadendral in their oils, that the greatest amount of oxalic acid seems to be formed, so that the abundance of lime in these trees may be necessary to combine with the excess of this acid. The alkalis in this group appear to be just as small in amount as the lime is abundant; in the ash of *E. albens* the potash (as K_2O) was 1·64 per cent., and this represented practically the whole of the alkalis present. It is thus not feasible to obtain potassium carbonate in quantity by burning the timbers of this group of Eucalypts. With the "Ironbarks" the lime is still in considerable amount, and the magnesia relatively increasing. The alkalis in this group, although greater in amount than in the "Boxes," do not appear to much exceed 25 per cent. of the total mineral constituents. The amount of magnesia in the ash-like timbers of *E. Delegatensis* and *E. regnans* is remarkable, even exceeding the lime in this respect, and the lime and magnesia taken together represent—as carbonates—about three-fourths of the entire mineral constituents of these trees, consequently the alkalis are comparatively small in this group also. This fact, taken together with the small ash yield, renders the timbers of these species of little use for the production of potassium carbonate. A greater amount of potassium could, of course, be obtained from the leaves of the more pronounced alkali-bearing species.

The data given in these tables suggest somewhat strongly the direction of chemical influences governing the natural distribution of the several species of the groups of this most extensive genus.

Table No. II.

		Percentage in Ash. (P_2O_5)	Percentage in Ash. (CaO)	Percentage in Ash. (MgO)
"Boxes"	*E. hemiphloia* (wood) ...	0·49	52·42	1·40
	E. albens (wood)	0·74	50·20	2·87
"Ironbarks"	*E. siderophloia* (wood) ...	1·58	31·14	6·55
	E. paniculata (wood) ...	1·64	28·12	7·29
"Ashes"	*E. Delegatensis* (wood) ...	1·50	19·50	23·42
	E. regnans (wood)	1·96	12·73	20·10
"Blackbutt"	*E. pilularis*, Ashfield (wood)	1·92	18·9	6·65
	do. mixed species (wood)	1·80	14·2	6·10
	do. No. 1 tree (leaves)	1·49	11·0	13·60
"Stringybarks"	*E. macrorrhyncha* (wood)	1·61	10·13	7·79
	E. eugenioides (wood) ...	1·41	11·23	6·30

The time at my disposal only permitted the investigation of a limited number of species of Eucalypts, in fact it was only possible to touch the fringe of this important question concerning the mineral food requirements of the members of the several groups of this great genus, but sufficient has been done to demonstrate somewhat clearly that great advantage to Australia would be likely to accrue from more complete and extended studies on this group of trees.

The natural vegetation of this continent represents one of its chief assets, and cannot be neglected without detracting from the general prosperity of the people. Considerable portions of the more settled States of Australia still remain available for extended effort in Forestry expansion, and in the State of New South Wales, in June 1912, the area included in Forest Reserves was 7,600,000 acres, although no less than 90,000 acres had been revoked from existing Forest Reserves during the year.

It is not desirable that land eminently suitable for agricultural purposes should be withheld from cultivation, or retained entirely for forestry purposes, although it is possible that by adopting this policy the cultivation of some well known economic species of Eucalyptus may be largely restricted. There are, however, so many other species which furnish timber of excellent quality for constructive works of various kinds, that this is after all a matter of minor importance; these species, too, often grow well upon soil far too poor to allow of its profitable employment in other directions. The land in Australia which is covered with Eucalyptus trees is often of indifferent quality, and to allow the difficulties of distribution to be overcome, Nature devised methods which at present are largely hidden from observation, but with which it is desirable that we should become better acquainted. Not only does this apply to species of particular value as timber trees, but also to those species which furnish products of economic value for various purposes.

Such knowledge can only be obtained by determined effort and by long continued researches in specialised directions.

To overcome the difficulties inherent to scientific investigations in Australia of such national importance, it seems desirable that scientists should be employed for this specific purpose alone, as it can hardly be expected that such work can proceed with the desired rapidity, or be altogether satisfactory, while the results are dependent upon the efforts of scientific officers whose time is so largely occupied with routine duties. As the results of this work would be of general value to Australia it seems fitting that the Federal authorities should provide the main portion of the funds necessary to carry on such important researches.

The Governments of some of the Australian States are—by the establishment of scholarships and in other ways—already providing money for the furtherance of research. The New South Wales Government in particular has been liberal in this respect, and has provided money for this purpose to be expended at the University and in other directions. But generous as this act may be considered, yet the amount is not sufficient to enable extensive investigations of a national character to be successfully carried out.

One might express a wish that the time is not far distant when those in authority will recognise the advisability of spending money unstintingly to further scientific investigations into the latent possibilities of the unique vegetable resources of this Continent, as well as for researches in other directions. It is hardly possible that too much money can be judiciously spent on researches of this nature, for without doubt, such expenditure would be eventually recouped many times over.

The establishment of Chairs in Organic Chemistry and Botany at the Sydney University, together with the increasing activity in the Organic Chemistry Classes at the Technical College, as well as similar advances made in the other States, will be the means of supplying the trained material from which that band of scientific workers may be recruited; men who by thought and sentiment will be stimulated to activity in the cause of Australian scientific progress, and whose ambition shall be to assist in the accumulation and arrangement of the scientific facts thus obtained, so that those deeper chemical and physiological reactions underlying the persistence of these natural forms may be brought to light and profitably utilised.

NAPIER COMMEMORATIVE LECTURE.

THE DISCOVERY OF LOGARITHMS BY NAPIER OF MERCHISTON.

By Professor H. S. Carslaw, Sc.D.

Delivered before the Royal Society of New South Wales at a Special Meeting held on May 21st, 1914, in celebration of the Tercentenary of the publication of the Mirifici Logarithmorum Canonis Descriptio.

The subject of our lecture to-night is the Discovery of Logarithms by Napier of Merchiston. This event was announced in his book, *Mirifici Logarithmorum Canonis Descriptio*, published in Edinburgh in 1614. Except for the Canon or Table of Logarithms, it is written in Latin. To quote from the title in the English Edition of 1616, it contains *A Description of the Admirable Table of Logarithmes: with a declaration of the most plentiful, easy and speedy use thereof in both kindes of Trigonometrie as also in all Mathematicall calculations.* This year, in many different countries, the ter-centenary of Napier's great discovery is being celebrated. The Royal Society of New South Wales joins in these celebrations, and I regard it as a great privilege that I have been invited to pay our tribute to the memory of a man whose service to the science